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HUMAN CAVADERS AND SKELETAL AND THEIR WEIGHT REFERENCES

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Abstract:

In the analysis of human remains, the information about weight is recoverable; but its references are scarcely available. Therefore, for the recently deceased persons and dry skeletons, the mean weight was documented to investigate combustion intensity, sex and age through univariate and multivariate statistics at Sir Ganga Ram Hospital, Lahore (October 2018). Fresh cadavers' cremains were heavier than the remains of dry skeletons without any due consideration of age and gender (P-Value < 0.001 to 0.003). Gender and age had a positive effect on the heaviness of the skeletal weight as males were heavier than females. The weight reference is helpful in the estimation of sex, skeletal completeness and number of individual.

Keywords: *Forensic Anthropology, Forensic Science, Cremation, Skeletal Weights, Heat-Induced Changes and Burned Bones.*

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INTRODUCTION:

Higher fragmentary nature makes the bioanthropological analysis difficult and complex. Anatomical identification of tooth and bone fragment is difficult along with reduced feasibility of reconstruction of elements which makes the overall assessment a difficult and problematic process. In contrast, the fragment does not affect the element of weight which is more helpful for the bone assessment [1]. Weight also helps in the estimation of minimum number identification and gender discrimination [2 – 4]. However, bio-anthropologists rely on the weight of skeletal to complement the outcomes extracted from traditional osteological methods [2, 5 – 9]. However, only relying on weight may also lead to inaccuracies especially in the context of archaeology. In the presence of whole remains the reliability is dependent on reliable source of weight. McKinley points out that such weights are not available in most of the cases and researcher needs to rely on available small weights [10].

It is difficult to recover weight references from burnt skeletons as heat reduces the weight of the skeletal [11, 12]. Decomposition and dehydration cause weight reduction with the loss of organic components and water [13, 14]. Weight loss in archaeological bone is 17% and in the fresh bone 60% [13, 15 – 18]. Loss of weight is more pronounced at higher temperatures [19].

The objective of this research is to investigate and document the factors related to a heat-induced weight loss of skeletons. These kind of research studies are helpful for the handling of postmortem without any reference with forensic contexts which may possibly relate to funerary practice or archaeological use.

MATERIALS AND METHODS:

Recently deceased persons and dry skeletons the mean weight was documented to investigate combustion intensity, sex and age through univariate and multivariate statistics at Sir Ganga Ram Hospital, Lahore (October 2018). The research was carried out after institutional permission. Technicians monitored all the procedures throughout the research with reference to cadaver specification. The first analysis included a total of sixteen adult cadavers which were cremated in the course of forty-eight hours after death. In the second analysis, there were eighty-eight skeletons who died in the course of last five years. Cremation was carried out on dry bones of the skeletons having mean inhumation period of (16.3 ± 15.8) years.

The sample included 51 females and 65 males with respective mean age of 74.5 years and 68.6 years. Skeletons sample contained 39 males and 49 females. The age at the time of death for females and males was respectively 72.6 years and 67.3 years. Most of the skeletons were not known for their age at the time of death. Soft tissues burnet in the course of sixty minutes within the range of (30 – 120) minutes of time span. Various factors like wood type, idiosyncrasies or combustion protocol were involved for this variation. Cremation length also depends on body mass, insulative skin distribution and thickness along with muscles [23, 26, 27]. After the completion of cremation process for every individual; bones remained in the cremator till full cool down along with an additional cooldown process outside of the cremator. McKinley approach was used for the sieving of remains through a 2-mm mesh which is more comparable with archaeological cremations [10]. Multiple regression analysis was carried out to investigate the functional association between skeletal weight, gender and age. Other tests included ANOVA, Chi-square test and Mann–Whitney test. SPSS software was used for statistical analysis of the outcomes.

RESULTS:

There was a significant statistical difference between mean skeletal weights of skeletons and cadavers regardless of age and sex. Skeletons systematically presented lighter cremains than cadavers. Both samples were separately examined for outcomes. Mean weights of males and females were different. The effect of age on the sample weight of females is restricted. Detailed outcomes about comparison of various studies, age cohort (cadavers versus skeletons), condition of the cadavers and skeletons, analysis of various values for with and without <2mm fraction, gender-wise analysis and gender-wise comparison for with and without <2mm fraction is given in the tabular and graphical representation.

Table – I: Comparison of Various Studies

Author	Cremation Parameters		Females			Males		
	(°C)	Duration	g	n	Age	g	n	Age
Malinowski and Porawski [20]	± 1000	–	1540	–	45 – 65	2004	–	45 – 65
Herrmann [21]	–	–	1700	226	76.2	1842	167	72.8
McKinley —no 2-mm fraction [10]	–	–	1272	6	81.6	1862	9	77.3
McKinley — with 2-mm fraction [10]	–	–	1616	6	81.6	2284	9	77.3
Sonek in Bass and Jantz [22]	–	–	1875	63	75.7	2801	76	64.1
Warren and Maples [23]	> 830	73 – 207′	1840	40	74.1	2893	51	66.3
Bass and Jantz [22]	871 – 982	120 – 180′	2350	155	70.7	3379	151	62.8
Chirachariyavej et al. [25]	850 – 1200	60 – 90′	2120	55	73.3	2680	55	63.5
Van Deest et al. [24]	871 – 927	120′	2238	363	76.1	3233	365	71.4

Table – II: Age Cohort (Cadavers Versus Skeletons)

Age Cohort	Cadavers			Skeletons		
	Females	Males	Total	Females	Males	Total
20 – 29 Years	0	0	0	0	1	1
30 – 39 Years	0	3	3	0	1	1
40 – 49 Years	5	4	9	2	1	3
50 – 59 Years	4	10	14	1	4	5
60 – 69 Years	8	15	23	1	3	4
70 – 79 Years	8	14	22	8	6	14
80 – 89 Years	22	17	39	10	2	12
90 – 99 Years	4	2	6	2	3	5
Adults of unknown age	0	0	0	25	18	43
Total	51	65	116	49	39	88

Table – III: Condition of the Cadavers and Skeletons

Condition	≤70		>70		≤70		>70	
	Cadavers	Skeletons	Cadavers	Skeletons	Cadavers	Skeletons	Cadavers	Skeletons
n	17	5	34	20	34	11	31	10
Median	1894.8	1697.4	1585.1	1219.6	2466.5	1944.7	2353.2	1728.8
Range	1439.6	525.5	1353.5	1142.7	2318.6	1372.6	1774.8	1280.2
Mann–Whitney	–		132		57		57	
Sig.	–		0		0.001		0.003	
Effect size	–		r = 0.51		r = 0.51		r = 0.47	

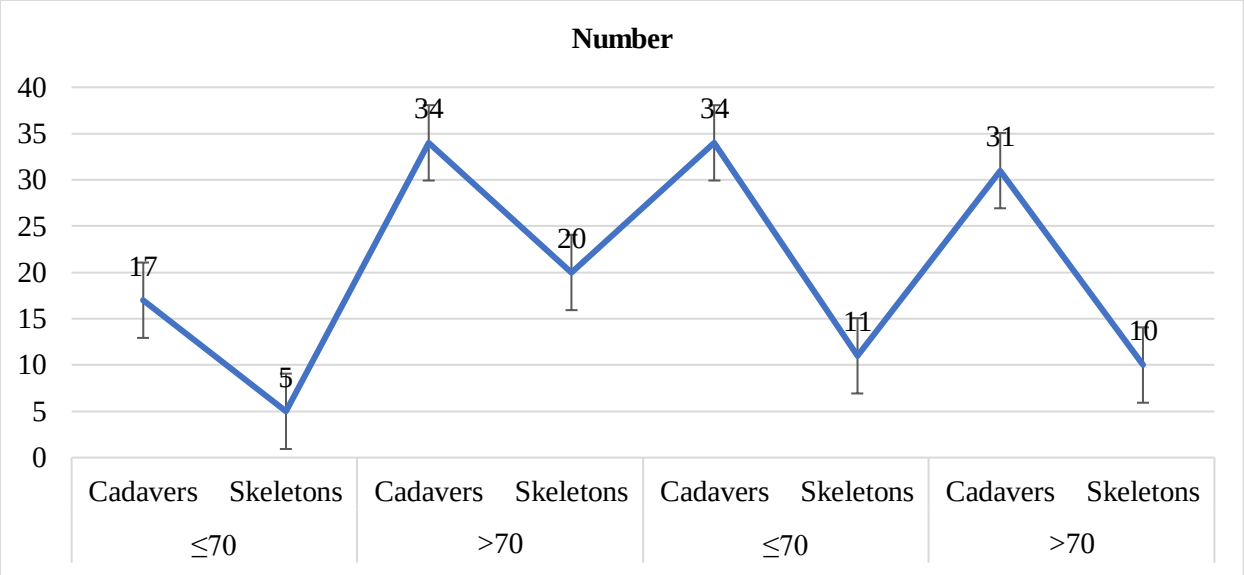


Table – IV: Analysis of various values for with and without <2mm fraction

		≤70	>70	Pooled	≤70	>70	Pooled
Number		17	34	51	34	31	65
Mean	No <2-mm fraction	1845.2	1556	1652.4	2520.5	2354.9	2441.5
	With <2-mm fraction	2451.1	2114.5	2226.7	3146.1	2916.4	3036.5
SD	No <2-mm fraction	344.2	322.9	354.5	449.4	422.7	441.4
	With <2-mm fraction	464.5	437.5	470.1	479.1	470.8	485.8
Median	No <2-mm fraction	1894.8	1585.1	1658	2466.5	2353.2	2420.7
	With <2-mm fraction	2507.5	2092.7	2207.7	3107.8	2940.4	2999.2
Range	No <2-mm fraction	1439.6	1353.5	1496.3	2318.6	1774.8	2318.6
	With <2-mm fraction	1950.7	1739.1	1956.5	2535.2	1965.5	2669.3
Minimum	No <2-mm fraction	980	923.3	923.3	1486.7	1512	1486.7
	With <2-mm fraction	1286.7	1280.9	1280.9	2036	1901.9	1901.9
Maximum	No <2-mm fraction	2419.6	2276.8	2419.6	3805.3	3286.8	3805.3
	With <2-mm fraction	3237.4	3020	3237.4	4571.2	3867.4	4571.2

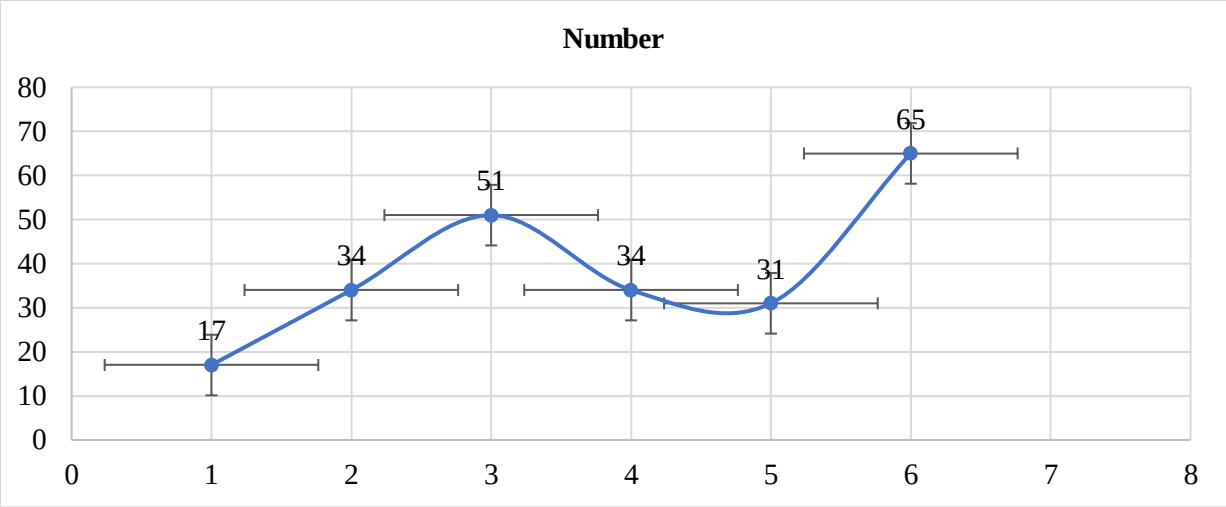


Table – V: Gender Wise Analysis

Gender	Duration of Combustion	Number	Mean	SD	95% CI	F	df	Sig.
Female	60 – 100′	17	1498	389	1298.2 – 1698.9	3.1	2, 48	0.05
	101 – 200′	19	1679	312	1528.4 – 1829.2			
	Overnight	15	1794	316	1619.1 – 1968.6			
Male	60 – 100′	23	2383	514	2160.3 – 2604.7	0.31	2, 62	0.73
	101 – 200′	18	2471	443	2250.9 – 2691.2			
	Overnight	24	2476	373	2318.3 – 2633.5			

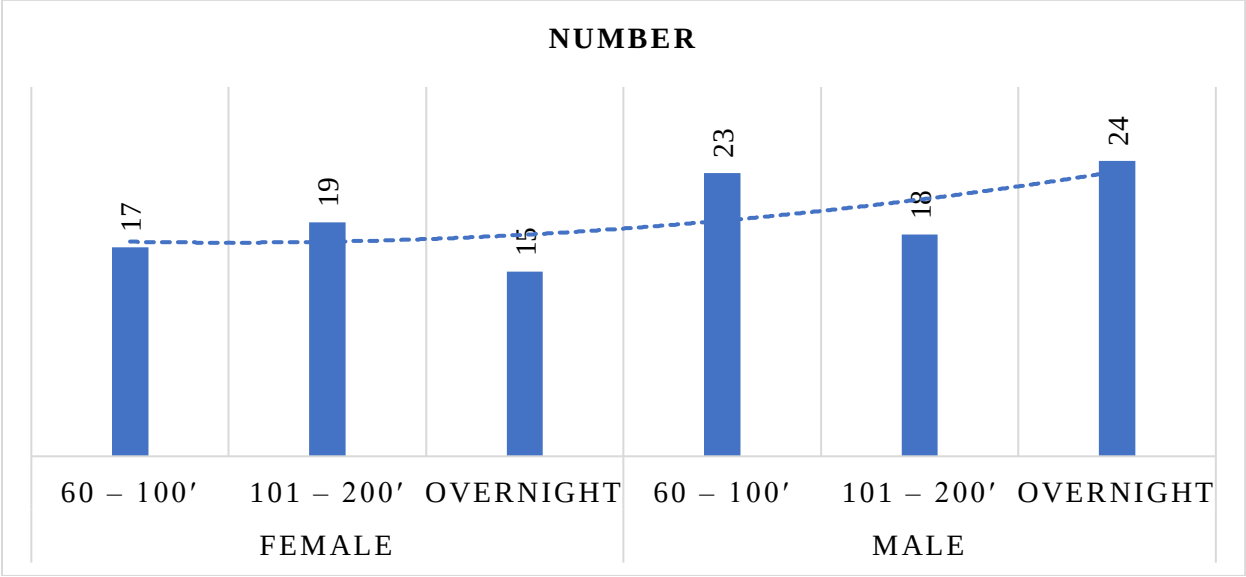
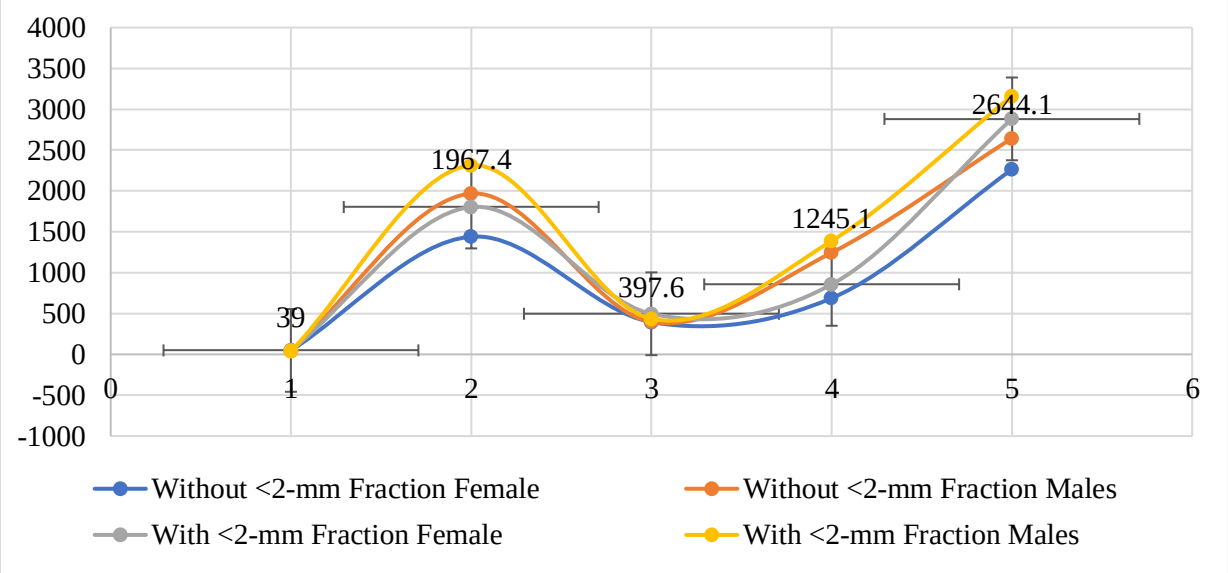


Table – VI: Gender Wise Comparison for with and without <2mm fraction

	Without <2-mm Fraction		With <2-mm Fraction	
	Female	**Males**	**Female**	**Males**
Number	49	39	49	39
Mean	1440.6	1967.4	1803.6	2313.5
SD	395.5	397.6	497.1	435.6
Minimum	688.3	1245.1	856.9	1389
Maximum	2263.2	2644.1	2882.5	3160.4



DISCUSSION:

An interesting outcome of the research was the difference in weight between cadavers and skeletal with difference in the age and sex cohort. Theoretically, no regional differences exist in the sample population and the inhumation period was also same for the selected samples. Moreover, the comparison between skeletons and cadavers is intrinsically different. Fresh cadavers are less exposed to heat which reduces the intensity of the heat on the bones due to protection of soft tissues. Skeletal weight should have an awareness about the pre-cremation conditions to draw eventual comparisons.

Outcomes also demonstrate that males are heavier than females for both skeletons and cadavers which is in agreement with other studies [10, 22 – 24, 28]. Female skeletal weight was also dependent on the age factor. Young females were heavier than old females [29]. Few researchers also reported similar effect for both genders [10, 20, 22, 25, 28]. Cadavers sample age composition may also lead to noon-similar outcomes for males. The sample did not include young rather it was composed of aged sample. Females were reported with age-related loss of weight which is comparable with enhancement in the bone loss in the course of menopause [22].

We failed to associate skeletal weight with combustion intensity. Apparently, combustion duration showed an impact on interacting variables. Length of cremation did not affect cremains weight. No correlation existed for maximum combustion temperature as 98% of cremation were carried out on a temperature of more than 800°C. Different outcomes were presented by that cremains who were burnt at low temperature. Few of the experiments also report that majority weight loss occurs under 400°C [16 – 18]. However, a negative association existed between reduced temperature and both variables which may have hindered the outcomes.

The outcomes compared with other authors with the addition of mean weight of bone categories with various amounts of elements such as scapula (26) and mandible (35) was also made [20]. We can also

compare weighing procedure as well. Our cadaver weight sample just heavy to their cadaver sample; whereas, relatively close to skeletal sample without 2-mm fraction. In contrast, Herrmann utilized larger sample of 393 in his series [21]. Our outcomes are different than the outcomes presented by Herrmann, he also not provided the weighing procedure. There was a large variation in the weight of the samples as reported by various authors [22 – 25]. Researchers also pointed out regional differences along with sex and age [22, 24, 28]. Few considered BMI and stature as related influencing factors [22 – 25, 28]. Values for males (>50 years) and females (>60 years) in different samples are given in Table – I [23, 25, 30 – 32].

CONCLUSIONS:

These observations of our research recommend that age, sex and regional differences are unable to explain the variation in the skeletal weight remains. Therefore, the consideration of other factors is also important. Some variations can be explained through combustion intensity. In addition, conflicting cremation and weighting procedures along with the use of different kinds of wood containers also significantly affect the weight of the skeletal remains. Gender and age had a positive effect on the heaviness of the skeletal weight as males were heavier than females. The weight reference is helpful in the estimation of sex, skeletal completeness and number of individual. Various conditions are to be satisfied in order to obtain reliable information which depends on the weight of the skeletal. A better understanding can be made through more supplementary research. Therefore, skeletal weights analysis is preferable to use as complementation for references obtained from osteological evaluation.

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